*HI = $(D_{2\%}-D_{98\%})/D_{50\%}$
§p: threshold for statistical significance p< 0.05

Conclusions: Our results indicate that both techniques are able to produce plans with a good coverage of PTVs and an acceptable sparing of the contralateral parotid gland for OPC, despite a slight advantage of RA for dosimetric analysis of PTV. In addition,the NTID was significantly lower with RA. However, the clinical benefit ofthese dosimetric advantages needs further investigation.

PO-0805
Combining VMAT and breath hold to reduce heart and lung dose for locoregional treatment of left-sided breast cancer
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Purpose/Objective: The significance of breath hold for reducing heart and lung dose for RT of left sided breast cancer, especially when internal mammary (IM) nodes are included, has been established by many investigators. In contrary, the role of volumetric modulated arc therapy (VMAT) is still debated: although the dose to the ipsilateral lung and heart may be decreased compared to conformal RT, the dose delivered to the contralateral breast and lung may be increased. In our study, we investigate the dose distribution of VMAT (RapidArc®) in combination with voluntary moderately deep inspiration breath hold (vmDIBH) for left-sided breast cancer patients treated to breast/chest wall and IM and periclavicular nodes.
Materials and Methods: A planning study of free breathing (FB) and vmDIBH in combination with conformal or RapidArc® plans is conducted on 10 patients, giving 4 possible combinations per patient. The following dosimetric parameters were compared: homogeneity index (HI) for PTV, doses to heart, lung, and contralateral breast.
Results: RapidArc® plans had a better HI: 0.82 for FB and 0.81 for vmDIBH vs. 0.73 (FB) and 0.75 (vmDIBH)] for 3D-CRT. The average doses to the total lung, heart and contralateral breast are displayed in the table for the first 3 patients.

		3D-CRT		RapidArc	
		FB	vmDIBH	FB	vmDIBH
Heart	V20 (%)	8.7	2.4	2.1	0.7
	V5 (%)	40.5	28.6	12.2	10.3
	Mean (Gy)	6.9	4.1	3.6	3.0
Lung	V20 (%)	16.9	14.4	7.2	6.8
	V5 (%)	36.4	32.0	34.9	32.7
	Mean (Gy)	8.1	7.1	6.1	5.6
CL breast	V20 (%)	0.3	0.5	0.0	0.0
	V5(%)	0.8	1.2	5.0	2.7
	Mean (Gy)	0.4	0.5	2.1	1.3

Conclusions: RapidArc® plans are superior compared to 3D-CRT for dose homogeneity to the PTV, heart dose and V20 and mean dose of the lung. This goes at the expense of a slightly increased dose to the contralateral breast. We confirm a decrease in heart dose using vmDIBH combined with 3D-CRT. Since the addition of vmDIBH to RapidArc® leads to a slight further improvement in heart dose, as well as a reduction of the dose to the contralateral breast, we conclude that the combination of RapidArc® and vmDIBH is a promising technique for locoregional RT for left sided breast cancer patients.

PO-0806
Pseudo-CT image HU conversion from MR image intensity values for MRI-based RTP of prostate cancer
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Purpose/Objective: The major challenge for MRI-based RTP is the lack of electron density information in the images. This research aimed to convert the T_1/T_2*-weighted MRI intensity values into electron density values in pelvis, and to enable accurate MRI-based RTP for prostate cancer patients.
Materials and Methods: Seventeen randomly chosen patients were set either into a data collection group (10 patients) or into a test group so that both of the groups included variety of different size patients. The standard CT image HUs and the MRI intensity values were analyzed for pelvic soft tissues of each data collection patient. By using the collected data a threshold based segmentation method was constructed to convert the soft tissues such as fat, muscle and urine, from MRI intensity values into HUs. For the bones our previously published[1, 2] conversion model was utilized with minor adjustments.The soft tissue HUs in the created pseudo-CT image of each test group patient were compared to the HUs in the standard CT image. Moreover, the dose distributions in the pseudo-CT images were compared to those in the CT images by using a 7-field IMRT plan.
Results: Figure 1 shows an example of the constructed pseudo-CT images. The comparison between results in the pseudo-CT images and in the standard CT images with pilot 7 test patients illustrated that the average deviations in each pelvic soft tissue were between 7 and 15 HUs. Furthermore, 91% of the investigated ROIs in the images were within 20 HUs, and 99% within 50 HUs. The average target doses (PTV volumes 5%, 50%, 95% and mean) in the pseudo-CT images were within 0.7% compared to those in the CT images. Over 1% dose deviations were detected with two patients. The improvements for dose calculation accuracy when using the soft tissue conversion instead of setting all soft tissues as water equivalent, but having bones converted with the same technique, were up to over 1 percentage unit (with obese patients).


Figure 1: A constructed MRI-based pseudo-CT image of a prostate cancer patient.

Conclusions: This study indicates that it is possible to construct pseudo-CT images by converting the MRI intensity values into electron density values in pelvis, and to use these images for accurate MRI-based prostate RTP. The examinations illustrated that by including the heterogeneous soft tissues into the pseudo-CT images the dose calculation accuracy can be improved especially with obese patients.
[1] Kapanen and Tenhunen, 'T1/T2*-weighted MRI provides clinically relevant pseudo-CT density data from pelvic bones in MRI-only based radiotherapy treatment planning.' Acta Onc., Early Online: 1-7, DOI:10.3109/0284186X.2012.692883, 2012.
[2] Korhonen et al, 'Absorbed doses behind bones with MR image-based dose calculations for radiotherapy treatment planning.' Med.Phys. 40 (1), 2013.

PO-0807
Comparison of two multileaf collimators for cranial intensity modulated radiosurgery
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Purpose/Objective: To compare two models of multileaf collimators (MLCs) with different leaf width for the treatment of intracranial lesions using intensity modulated radiosurgery (IMRS) technique.
Materials and Methods: Eclipse TPS (version 10.0) was used to compute IMRS plans for 20 cases of small brain lesions (range: 0.5 to 18.3 cc). Two differents models of MLC (Varian) were configured in Eclipse for a Varian Clinac 2100 CD: one with standard 5 mm leaf width ('STD') and the other with 2.5 mm leaf width ('HD'). For each patient, two IMRS plans were created using the same beam arrangement, same constraints during the optimization process,same number of optimization cycles, same dose calculation algorithm (AAA, 1 mm calculation grid size),and same dose prescription (99% of the target volume receiving the 100% prescriptiond ose); but each plan had a different MLC device, resulting a 'standardplan' and a 'HD plan' for each patient. Resulting plans for each patient were compared in terms of: 1) conformity index (CI; RTOG definition); 2) dose gradient (G; defined as the difference between the equivalent sphere radius of the prescription and half-prescription isodoses); 3) volume of normal brain receiving 12 Gy or more (V12) and 4) normal tissue volume (NTD) receiving the 50%, 70% and 90% of prescription dose (NTD50, NTD70

and NTD90, rep.). NTD parameter was evaluated in a virtual structure consisting of an adjacent tissue shell surrounding the target volume by adding a 1 cm margin. A two tailed Student t-test (α= 0.05) was performed for comparison of each parameter.
Results: Small differences were found between the two MLCs for the average values of the dosimetric parameters analysed: CI_{STD}= 1.45 *vs* CI_{HD}= 1.41 (p= 0.119); G_{STD}=5.8 mm *vs* G_{HD}= 5.6 mm (p< 0.0002) ; $V12_{STD}$=5.77 cc *vs* $V12_{HD}$= 5.49 cc (p< 0.02); $NTD50_{STD}$= 43.41 cc *vs* $NTD50_{HD}$= 41.16 cc (p< 0.01); $NTD70_{STD}$= 22.62 cc *vs* $NTD50_{HD}$ = 21.19 cc (p<0.002); and $NTD90_{STD}$= 9.52 cc *vs* $NTD90_{HD}$= 8.84 cc (p< 0.02).
Conclusions: While the 2.5 mm HD MLC gives slightly better values than the 5 mm MLC for all parameters analysed, the differences seem clinically not relevant.

PO-0808
Dosimetric impact of extended 16-bit depth CT images for helical irradiation with metallic implants
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Purpose/Objective: The use of 16-bit depth scanner images (CT) for dose calculation in radiotherapy allows considering the density of high-Z material, while12-bit depth CT saturates. The aim of this study is to evaluate the dosimetric impact of metallic implants considering 12 and 16-bit CT images, for helical treatments. Pelvic, Head and Neck and prostheses irradiations are considered.
Materials and Methods: Dosimetric calculations were performed withTomoTherapy® planning software (voLO™). Extended CT to physical density curve (CT-PD) was derived from tissue characterization phantom with Titanium insert (7200 ± 90 HU , 4.59 g/cc). TomoTherapy® planning software extrapolates linearly the CT-PD curve for HU numbers above the maximum point of the curve. Ten patients were considered for each of the 3 localizations. For each patient, an extended (16-bit) and non-extended (12-bit) version of the same CT were reconstructed. Artifacts in soft tissues due to metallic implants were manually corrected. Moreover, as reference, a metal-free CT was created for each patient by replacing metallic densities with bone, teeth or soft tissue densities. For helical irradiation, all gantry angles were allowed. Number of Monitor Unit (MU), dose distribution andHistogram-Dose-Volume (HDV) were compared.
Results: For 12-bit CT, metallic implants saturates at 3071 HU (2.68 g/cc), while for 16-bit CT, range CT numbers were [7000-16500 HU](i.e. [4.76 – 9.51 g/cc]) and [5000-31700 HU] (i.e. [3.76 – 17.11 g/cc]) for hip prostheses and metallic dental filling, respectively. For Head and Neck and pelvic helical irradiations, no significant differences were observed for MU and dose distribution, between calculation from 16-bit, 12-bit and metal-free CT. For prostheses irradiation, MU calculation from 12-bit depth CT and metal-free CT are similar, while calculation from 16-bit depth CT increased MU calculation more than 5%.
Conclusions: Real physical densities of metallic implants such as prosthese sand dental filling are much higher than maximal density of 12-bit depth CT images. However, for helical treatment, due to the important number of projections, metallic implants such as prostheses and dental filling have a negligible impact on dose calculation for non-metallic targets. Therefore, avoiding metallic structures is not necessary allowing a better target-dose conformity and organ-at-risk sparing. On the contrary, for metallic irradiation, the use of non-saturated images increases significantly MU calculation (>5%). However, the extrapolation of CT-PD curve and accuracy of algorithms in high densities medium should be investigated. Modification in practice for metallic targets should be considered carefully.

PO-0809
A plea for the GTV median dose reporting in SBRTCan the ICRU 83 reporting way be applied to SBRT plans?
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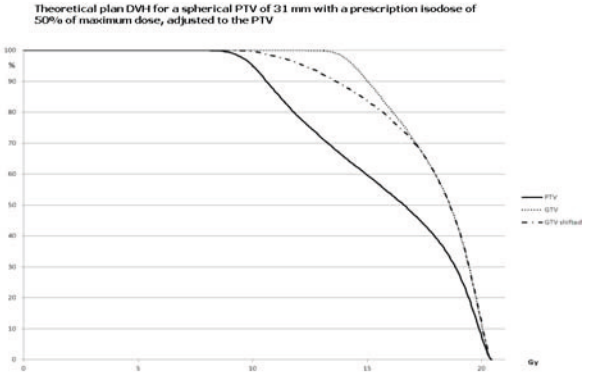
Purpose/Objective: In 2008 Papiez and Timmerman have written*: 'The main obstacle for safe application of the SBRT (...) is the unavailability of data that allow unambiguous determination of the parameters for fractionation schemes and dose prescriptions*.' Plan comparison is difficult with various prescriptions (80% of maximum dose, on the 70% or 50%), a large variety of indexes are used (conformity, gradient …). Furthermore in clinical studies, only one dose is reported most of the times which does not permit to precisely describe the dose distribution. In 2010 the report of AAPM TG 101 suggests to report SBRT with *'prescription ICRU reference point or dose/volume e.g., isodose covering PTV to a particular percentage,(…), plan conformity (…), heterogeneity index (…)'*. At the same time ICRU report 83 for IMRT was published, because of inherent heterogeneities of IMRT plans the ICRU point is abandoned and prescription is based on median target dose. Can we conciliate these 2 reports?
Materials and Methods: Theoretical plans with Cyberknife, in anthropomorphic phantom, for spherical GTV of 2, 3, 4 and 5 mm with a PTV margin of 1 mm were created with prescription of 10 Gy on 74%, 65%, 54% and 47% of maximum dose respectively, perfectly adjusted to cover 95% of PTV. GTV median doses were collected. Plans with a shift equal to the PTV margin, in the direction of the minimum observed in the dose distribution, were created and the GTV median doses were again collected. The same exercise was made with GTV of 21, 23, 25, 27 mm and a PTV margin of 2 mm. And again with GTV of 57, 59, 61, 63 mm and a PTV margin of 3 mm. 3 different clinical situations: brain metastases, prostate and lung lesion were assessed with different percentage of maximum dose used for prescription and again applying a shift.
Results: The GTV median dose is little sensitive to the minimum in the PTV, and thus remains almost constant with the shift of the isocenter in all cases i.e. when we imagine a systematic error equal to the PTV margin. With the 6 mm PTV and a prescription isodose of 54%, i.e. with a fall-off of 20%/mm at the edge of the PTV, the GTV median dose is 14.77 Gy and 14.75 Gy with the shift. For the particular case of lung where the PTV includes a low density region, using Monte-Carlo calculation, the GTV median dose is also stable with the shift. In case of a steep dose gradient, even with heterogeneity, the GTV median dose is stable when the GTV moves within the PTV. Using the GTV median dose we have a good description of the actually dose delivered.

Theoretical plans with a PTV margin of 2 mm

PTV diameter (mm)	31	29	27	25
GTV diameter (mm)	27	25	23	21
prescription isodose in % of max PTV D95% = 10 Gy	49%	59%	71%	81%
GTV median dose (Gy)	17,9	15,4	13,2	11,7
GTV median dose (Gy) with a shift	17,9	15,4	13,3	11,7
differences	0,0%	0,0%	0,1%	0,0%



Conclusions: The GTV D50% appears to be a convenient way to describe the dose distributions, whatever the % of maximum dose used for prescription, and may help for treatment comparison in SBRT. For a better understanding of the dose distributions, every team should report PTV D98%, PTV D95%, PTV D2% and GTV median dose like ICRU report 83 recommends for IMRT, in order to compare clinical studies.

PO-0810